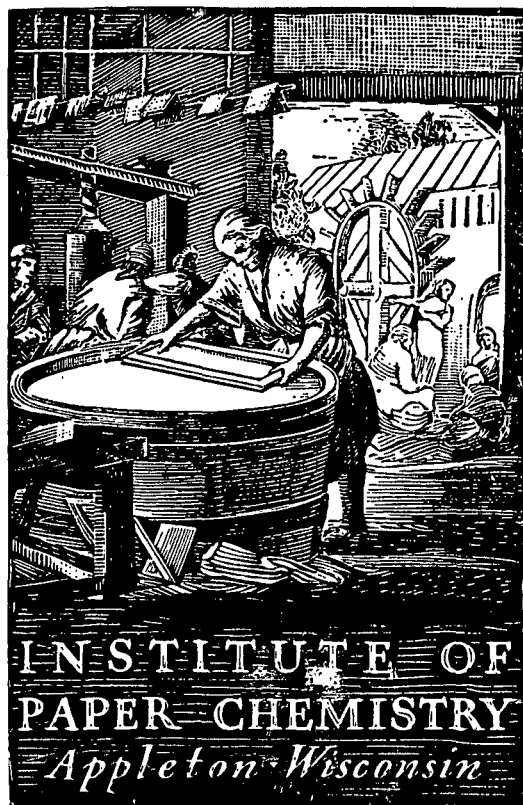


TECHNICAL



SURVEY OF "COLOR" OF 42-LB. UNBLEACHED
KRAFT LINERBOARD

Project 2694-8

Report One

A Summary Report

to

TECHNICAL DIVISION

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

October 15, 1971

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
SAMPLING AND TEST PROCEDURE	2
DISCUSSION OF RESULTS	3
APPENDIX I. SAMPLE DISPLAY	9

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

SURVEY OF "COLOR" OF 42-LB. UNBLEACHED KRAFT LINERBOARD

INTRODUCTION

A comparative evaluation of the "color" of 42-lb. unbleached kraft liner has been carried out to determine the "color" variations present in current "industry" production. Color is characterized in terms of (a) luminous reflectance, (b) standard brightness measured by means of the Brightness tester, (c) brightness measured by means of the Photovolt tester. This survey includes 140 samples from 47 machines of the following companies:

Alabama Kraft Company
Alton Box Board Company
Boise Cascade Papers
Boise Southern Company
The Chesapeake Corporation
Container Corporation of America
Continental Can Company, Inc.
Crown Zellerbach Corporation
Georgia Kraft Company
Georgia-Pacific Corporation
Great Northern Paper Company
Hoerner Waldorf Corporation

International Paper Company
MacMillan Bloedel United Inc.
Olinkraft, Inc.
Owens-Illinois, Inc.
Pineville Kraft Corporation
St. Joe Paper Company
St. Regis Paper Company
Tenn. River Pulp & Paper Company
Union Camp Corporation
Westvaco Corporation
Weyerhaeuser Company

All samples are identified by code number.

SAMPLING AND TEST PROCEDURE

Each company was requested to submit three samples from each machine which produced 42-lb. unbleached kraft linerboard during the past six months. The samples were to be selected from normal production - i.e., no special production was to be included. The three samples from a given machine were to be selected so as to represent the "normal," darkest, and lightest production of 42-lb. unbleached linerboard of the machine in question during the six-month period.

Code numbers were assigned to each set of three samples as follows:

Mill Designation	Code Number
Normal sample	Lowest number
Darkest sample	Intermediate number
Lightest sample	Highest number

For example, Code Numbers 10, 11, and 12 represent the normal, darkest, and lightest samples, respectively, from a given machine.

In most cases a sample consisted of six 12 x 12-inch sheets. One specimen for luminous reflectance and standard brightness, and one specimen for Photovolt brightness, were cut from each of five sheets, material permitting, to give a total of five readings per sample per type of measurement. The determinations were made on the side opposite the wire side.

DISCUSSION OF RESULTS

The results for all machines are summarized in Table I. Separate tabulations for the southern and western machines are shown in Tables II and III, respectively. In each table the results are arranged in ascending order of luminous reflectance based on the normal sample.

In some instances the mill designations of the normal, darkest, and lightest samples did not correspond with the luminous reflectance readings. In these cases the sample order was changed in tabulating the data to correspond with the luminous reflectance readings. For example, in Table I, Sample 46 which was designated normal by the mill exhibited a lower luminous reflectance than the darkest sample for that mill (Code No. 47). Accordingly, the results for Sample 47 were tabulated in the Normal column and the results for Sample 46 in the Darkest column.

The average, maximum, minimum, and standard deviation values are based on the results for the normal samples only.

Table IV shows frequency distributions based on the normal samples.

Appendix I contains a display of the 140 samples. The specimens are cut 1-1/2 inches C.D. by 2 inches M.D. and are displayed wire side down.

The specimens are arranged in Appendix I in the same order as shown in Table I - i.e., from darkest to lightest in terms of luminous reflectance of the "normal" sample from each machine. The darkest normal sample is located at the upper left corner of the first folded page and the lightest normal sample is located at the lower right corner (Normal column) of the second folded page.

TABLE I (Contd)

COMPOSITE DATA FOR ALL MACHINES

Code No.	Luminous Reflectance, %		Standard Brightness, %		Photovolt Brightness, %	
	Normal	Darkest	Normal	Darkest	Normal	Darkest
109, 110, 111	26.7	25.1	16.0	14.7	24.1	22.4
1, 2, 3	26.9	23.9	16.4	14.3	24.0	21.6
16, 17, 18	26.9	26.8	16.9	16.8	25.2	25.0
88, 89, 90	26.9	23.8	15.6	13.2	24.0	22.1
76, 77, 78	27.0	24.4	16.5	14.7	24.8	22.9
13, 14, 15	27.3	25.0	16.6	15.4	24.2	22.7
133, 134, 135 ^b	27.3	27.3	16.3	16.2	24.8	25.3
74, 73, 75 ^a	27.4	27.3	17.0	17.0	24.7	25.1
124, 125, 126 ^b	27.4	25.4	16.3	14.6	26.0	23.9
136, 137, 138	27.5	26.1	17.1	15.8	25.0	24.1
115, 116, 117	27.7	25.6	16.9	15.6	24.4	23.1
8, 7, 9 ^a	28.2	27.4	17.6	17.3	25.0	25.0
40, 41, 42	28.3	26.6	17.9	16.7	26.2	25.1
79, 80, 81	28.4	26.8	18.5	16.7	25.6	24.0
49, 50, 51 ^{a, b}	28.5	26.4	17.2	15.7	25.5	23.5
27, 26, 25 ^{a, b}	28.7	28.3	17.1	16.6	25.1	25.3
43, 44, 45	34.3	28.3	22.1	17.6	30.5	26.5
Average	26.3		15.8		24.0	
Maximum	34.3		22.1		30.5	
Minimum	21.1		12.4		20.7	
Standard deviation	1.87		1.48		1.52	

^a Mill designations of Normal, Darkest and Lightest Brightness did not correspond with Luminous Reflectance results. Therefore, the sample order was changed in the tabulation to correspond with the Luminous Reflectance readings.

^b Western machines.

^c No sample submitted.

TABLE II

RESULTS ON SOUTHERN SAMPLES

Code No.	Luminous Reflectance, %			Standard Brightness, %			Photovolt Brightness, %		
	Normal	Darkest	Lightest	Normal	Darkest	Lightest	Normal	Darkest	Lightest
34,35,36	23.5	22.5	25.8	13.9	13.3	15.0	21.6	21.0	23.2
4,5,6	23.6	19.1	24.7	13.3	10.8	14.1	20.8	18.1	21.9
53,52,54 ^a	23.8	23.3	27.1	14.0	13.7	16.3	21.9	22.0	22.9
95,94,96 ^a	24.6	24.1	25.9	15.0	14.0	15.5	23.6	22.3	23.9
127,128,129	24.7	24.3	26.0	14.7	14.2	15.5	22.4	22.1	23.6
62,61,63 ^a	24.7	24.4	26.0	15.2	15.1	15.8	23.4	23.5	24.3
37,38,39	25.0	23.7	27.9	14.8	14.3	17.4	23.2	22.3	24.8
69,68,67 ^a	25.1	23.4	25.9	15.2	13.8	15.4	23.7	22.7	24.4
22,23,24	25.3	24.9	30.8	15.3	14.7	18.2	23.5	23.0	26.2
112,113,114	25.5	24.3	30.5	15.2	14.5	18.7	23.6	22.4	27.2
141,140,139 ^a	25.6	24.6	25.7	15.0	14.1	15.0	23.2	22.7	23.2
121,122,123	25.7	22.6	28.2	15.3	12.6	17.5	22.9	20.5	25.6
58,59,60	25.8	20.6	28.1	14.8	11.2	16.7	23.0	19.9	24.5
10,11,12	25.8	23.3	27.4	15.1	13.5	16.4	23.3	21.8	24.2
82,83,84	25.8	23.9	27.9	14.9	14.0	16.7	22.7	21.7	24.1
97,98,99	25.9	24.2	25.9	15.8	14.4	16.0	23.9	22.1	23.1
143,142,144 ^a	25.9	25.6	26.0	15.4	15.1	15.5	23.5	23.4	23.4
28,29,30	26.0	23.6	27.1	16.1	14.7	17.1	24.2	22.7	24.8
85,86,87	26.0	25.9 ^b	26.7	15.2	14.9 ^b	15.5	23.9	23.2 ^b	23.9
31,32,33	26.0	-- ^b	28.2	15.0	-- ^b	17.1	22.9	-- ^b	25.1
106,107,108	26.2	22.1	28.6	15.3	12.6	17.6	23.7	21.0	25.7
130,131,132	26.2	21.3	29.6	16.1	13.0	18.8	24.2	20.7	27.0
55,56,57	26.5	25.2	26.9	15.3	14.3	15.7	24.8	23.7	25.1
100,101,102	26.6	22.8	27.4	15.8	13.1	16.3	24.0	21.5	25.0
91,92,93	26.6	25.7	28.9	15.3	14.8	17.0	23.6	23.6	25.3
109,110,111	26.7	25.1	28.6	16.0	14.7	16.9	24.1	22.4	24.6
1,2,3	26.9	23.9	28.7	16.4	14.3	17.9	24.0	21.6	25.5
16,17,18	26.9	26.8	29.4	16.9	16.8	18.5	25.2	25.0	26.4
88,89,90	26.9	23.8	29.7	15.6	13.2	17.2	24.0	22.1	26.3
76,77,78	27.0	24.4	28.6	16.5	14.7	18.6	24.8	22.9	26.2
13,14,15	27.3	25.0	28.5	16.6	15.4	17.9	24.2	22.7	25.5
74,73,75 ^a	27.4	27.3	27.7	17.0	17.0	17.1	24.7	25.1	25.4
136,137,138	27.5	26.1	28.0	17.1	15.8	17.1	25.0	24.1	25.7
115,116,117	27.7	25.6	29.6	16.9	15.6	18.5	24.4	23.1	26.2
8,7,9 ^a	28.2	27.4	28.6	17.6	17.3	18.0	25.0	25.0	25.4
40,41,42	28.3	26.6	28.7	17.9	16.7	18.3	26.2	25.1	26.5
79,80,81	28.4	26.8	29.1	18.5	16.7	18.1	25.6	24.0	25.1
49,50,51	28.5	26.4	29.2	17.2	15.7	17.7	25.5	23.5	26.0
Average	26.2			15.7			23.8		
Maximum	28.5			18.5			26.2		
Minimum	23.5			13.3			20.8		
Standard deviation	1.27			1.12			1.10		

^aMill designations of Normal, Darkest and Lightest Brightness did not correspond with Luminous Reflectance results. Therefore, the sample order was changed in the tabulation to correspond with the Luminous Reflectance readings.

^bNo sample submitted.

TABLE III
 RESULTS ON WESTERN SAMPLES

Code No.	Luminous Reflectance, %			Standard Brightness, %			Photovolt Brightness, %		
	Normal	Darkest	Lightest	Normal	Darkest	Lightest	Normal	Darkest	Lightest
47,46,48 ^a	21.1	20.7	23.8	12.4	11.9	13.9	20.7	20.2	22.9
64,65,66	25.2	23.8	26.3	14.7	13.8	15.7	23.4	22.4	24.2
19,20,21	25.7	23.9	27.5	15.8	14.0	16.7	23.4	22.5	24.7
118,119,120	26.4	23.6	27.4	15.6	13.4	16.4	23.6	21.8	24.5
70,71,72	26.6	24.5	27.5	15.7	14.2	16.2	24.5	23.7	25.0
133,134,135	27.3	27.3	30.8	16.3	16.2	19.6	24.8	25.3	26.9
124,125,126	27.4	25.4	28.2	16.3	14.6	16.7	26.0	23.9	26.2
27,26,25 ^a	28.7	28.3	29.3	17.1	16.6	17.0	25.1	25.3	25.1
43,44,45	34.3	28.3	36.2	22.1	17.6	24.3	30.5	26.5	32.8
Average	27.0			16.2			24.7		
Maximum	34.3			22.1			30.5		
Minimum	21.1			12.4			20.7		
Standard deviations	3.48			2.58			2.65		

^a Mill designations of Normal, Darkest and Lightest Brightness did not correspond with Luminous Reflectance results. Therefore, the sample order was changed in the tabulation to correspond with the Luminous Reflectance readings.

TABLE IV

FREQUENCY DISTRIBUTIONS BASED ON NORMAL SAMPLES

Range	Composite		Western		Southern	
	No.	%	No.	%	No.	%
<u>Luminous Reflectance</u>						
21.0 - 21.9	1	2.1	1	11.1	---	--
---	--	--	--	--	---	--
23.0 - 23.9	3	6.4	--	--	3	7.9
24.0 - 24.9	3	6.4	--	--	3	7.9
25.0 - 25.9	13	27.7	2	22.2	11	28.9
26.0 - 26.9	14	29.8	2	22.2	12	31.6
27.0 - 27.9	7	14.9	2	22.2	5	13.2
28.0 - 28.9	5	10.6	1	11.1	4	10.5
---	--	--	--	--	--	--
---	--	--	--	--	--	--
---	--	--	--	--	--	--
---	--	--	--	--	--	--
---	--	--	--	--	--	--
34.0 - 34.9	1	2.1	1	11.1	--	--
<u>Standard Brightness</u>						
12.0 - 12.9	1	2.1	1	11.1	--	--
13.0 - 13.9	2	4.3	--	--	2	5.3
14.0 - 14.9	6	12.8	1	11.1	5	13.2
15.0 - 15.9	20	42.6	3	33.3	17	44.7
16.0 - 16.9	10	21.3	2	22.2	8	21.1
17.0 - 17.9	6	12.8	1	11.1	5	13.2
18.0 - 18.9	1	2.1	--	--	1	2.6
---	--	--	--	--	--	--
---	--	--	--	--	--	--
---	--	--	--	--	--	--
22.0 - 22.9	1	2.1	1	11.1	--	--
<u>Photovolt Brightness</u>						
20.0 - 20.9	2	4.3	1	11.1	1	2.6
21.0 - 21.9	2	4.3	--	--	2	5.3
22.0 - 22.9	4	8.5	--	--	4	10.5
23.0 - 23.9	17	36.2	3	33.3	14	36.8
24.0 - 24.9	13	27.7	2	22.2	11	28.9
25.0 - 25.9	6	12.8	1	11.1	5	13.2
26.0 - 26.9	2	4.3	1	11.1	1	2.6
---	--	--	--	--	--	--
---	--	--	--	--	--	--
---	--	--	--	--	--	--
30.0 - 30.9	1	2.1	1	11.1	--	--

APPENDIX I

SAMPLE DISPLAY

Number	Normal	Darkest	Lightest
47, 46, 48			
34, 35, 36			
5, 2, 6			
53, 52, 54			
95, 94, 96			
107, 108, 109			
62, 61, 63			
71, 68, 69			
64, 63, 67			
65, 64, 66			
77, 76, 78			
111, 113, 114			

Code No.

Normal

Darkest

Lightest

141, 140, 139

121, 122, 123

19, 20, 21

58, 59, 60

10, 11, 12

82, 83, 84

97, 98, 99

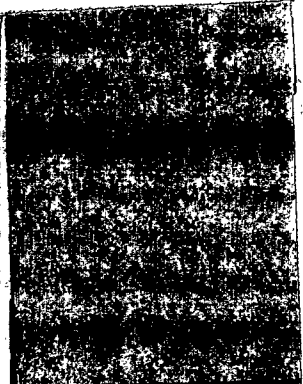

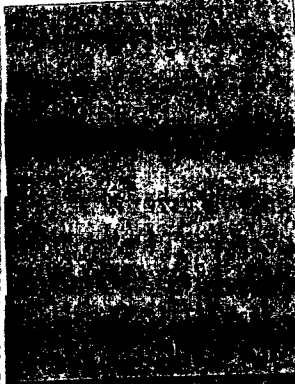
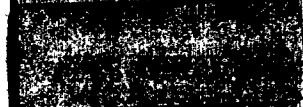




















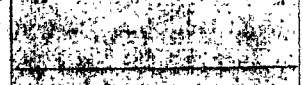











143, 142, 144

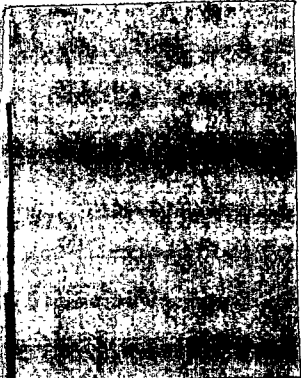
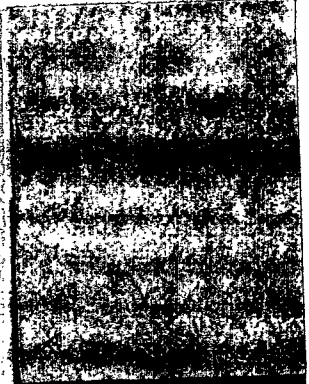
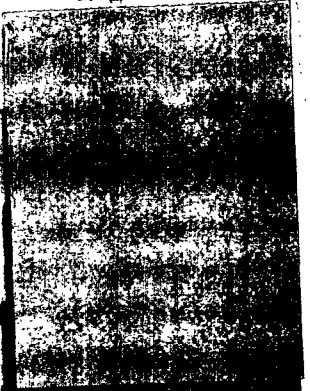

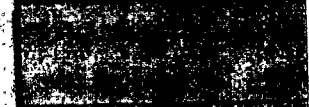

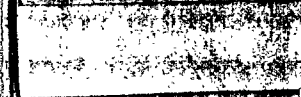


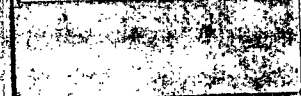





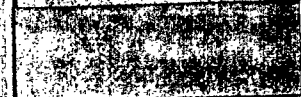
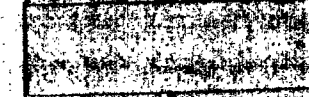




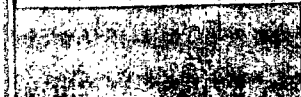

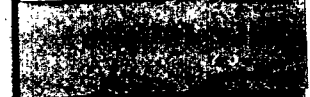






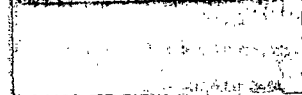
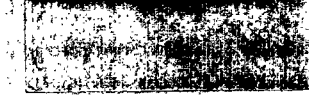

28, 29, 30

85, 86, 87

31, 32, 33

106, 107, 108

Code No.	Normal	Darkest	Lightest
130, 131, 132			
118, 119, 120			
55, 56, 57			
100, 101, 102			
70, 71, 72			
91, 92, 93			
109, 110, 111			
1, 2, 3			
16, 17, 18			
88, 89, 90			
76, 77, 78			
13, 14, 15			

Code No.	Normal	Darkest	lightest
133, 134, 135			
74, 73, 75			
124, 125, 126			
136, 137, 138			
115, 116, 117			
8, 7, 9			
40, 41, 42			
79, 80, 81			
49, 50, 51			
27, 26, 25			
43, 44, 45			

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1 2 3 4 5 6 7 8 9

10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27